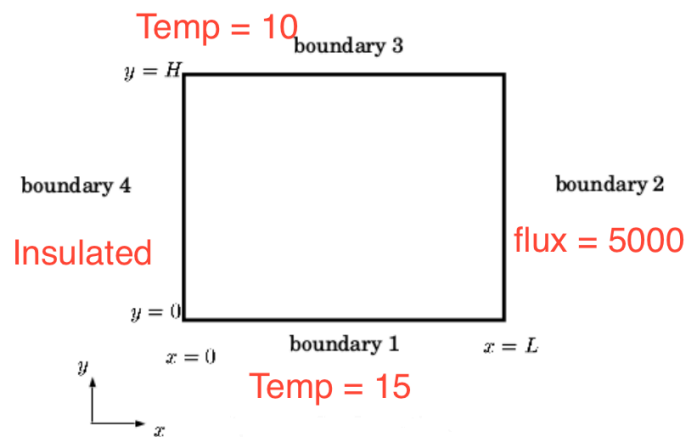


Steady 2D Diffusion

Computational Fluid Dynamics (AM5630) Assignment 2

Mohamed Mafaz , Roll no : AM25M009

1. Mesh Geometry



$$L = 1$$

$$H = 0.5$$

$$T_1 = 15$$

$$T_2 = q = +5000$$

$$T_3 = 10$$

$$T_4 = dT/dx = 0 - 1.5 \cdot 16(y/H + 1)$$

STEP 1 first create a differential 2D Control Volume with

length along x Δx

length along y Δy

n required number of such differential control volumes required to construct

full CV

1.2 Computation

STEP 1 identify the boundary nodes and apply the boundary conditions

SOUTH boundary (Dirichlet T_S) – bottom edge

$$a_E = \frac{k_{cell} \Delta y}{\delta_{xe}}, \quad a_W = \frac{k_{cell} \Delta y}{\delta_{xw}}, \quad a_N = \frac{k_{cell} \Delta x}{\delta_{xn}}, \quad a_S = \frac{2k_{cell} \Delta x}{\delta_{xs}} \quad (\text{half-cell})$$

Centre coefficient:

$$a_P = a_E + a_W + a_N + a_S.$$

RHS (source):

$$S_u = -1.5 \Delta x \Delta y + a_S T_S.$$

NORTH boundary (Dirichlet T_N) – top edge

$$a_E = \frac{k_{cell} \Delta y}{\delta_{xe}}, \quad a_W = \frac{k_{cell} \Delta y}{\delta_{xw}}, \quad a_S = \frac{k_{cell} \Delta x}{\delta_{xs}}, \quad a_N = \frac{2k_{cell} \Delta x}{\delta_{xn}} \quad (\text{half-cell})$$

Centre coefficient:

$$a_P = a_E + a_W + a_N + a_S.$$

RHS (source):

$$S_u = -1.5 \Delta x \Delta y + a_N T_N.$$

EAST boundary (Neumann flux q_E) – right edge

Neumann: flux q_E = 5000.

$$a_N = \frac{k_{cell} \Delta x}{\delta_{xn}}, \quad a_S = \frac{k_{cell} \Delta x}{\delta_{xs}}, \quad a_W = \frac{k_{cell} \Delta y}{\delta_{xw}}, \quad a_E = 0 \quad (\text{no neighbor}).$$

Centre coefficient:

$$a_P = a_N + a_S + a_W$$

RHS (source):

$$S_u = -1.5 \Delta x \Delta y + q_E \Delta y + (a_N T_N \text{ if north boundary}) + (a_S T_S \text{ if south boundary}).$$

West boundary (left edge)

Neumann: insulated ($q=0$).

$$a_E = \frac{k_{cell} \Delta y}{\delta_{xe}}, \quad a_N = \frac{k_{cell} \Delta x}{\delta_{xn}}, \quad a_S = \frac{k_{cell} \Delta x}{\delta_{xs}}, \quad a_W = 0 \quad (\text{insulated}).$$

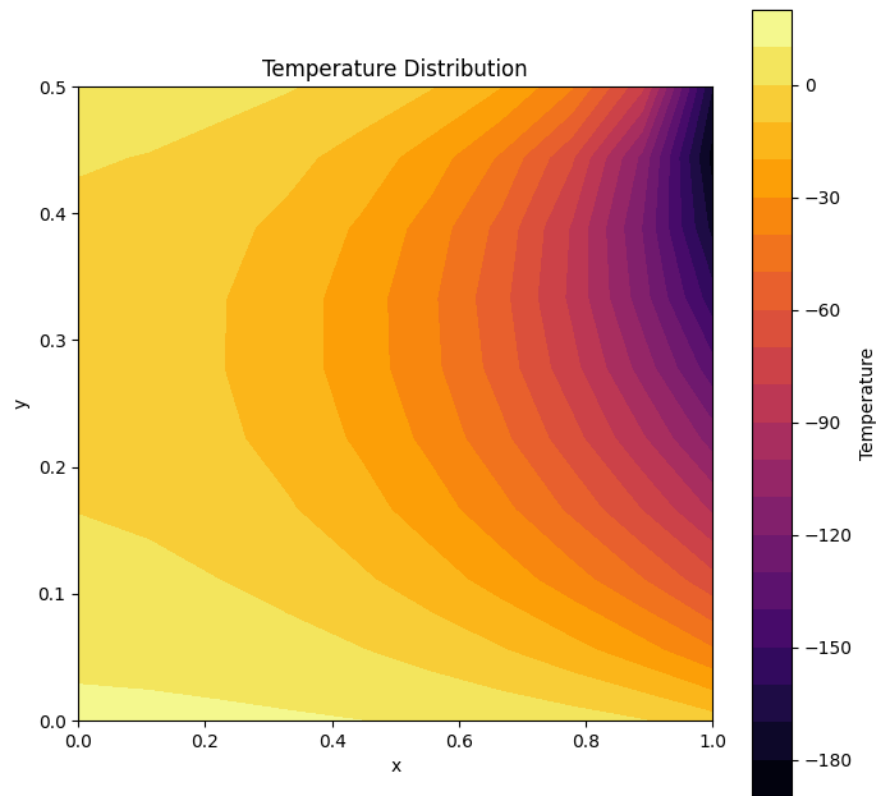
Centre coefficient:

$$a_P = a_E + a_N + a_S.$$

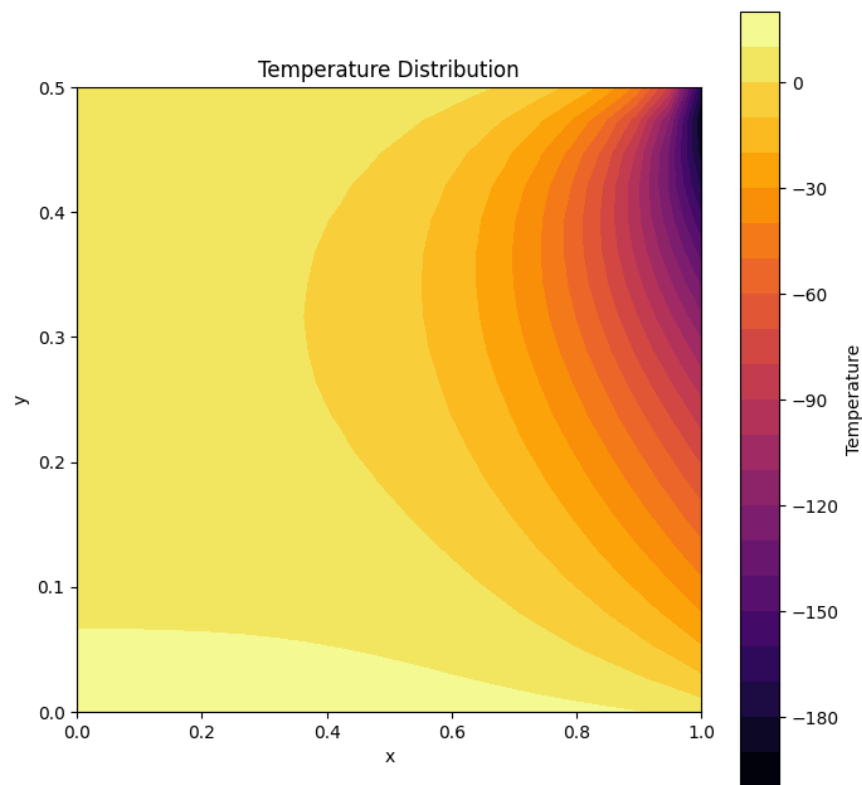
RHS (source):

$$S_u = -1.5 \Delta x \Delta y + (a_N T_N \text{ if top-left corner}) + (a_S T_S \text{ if bottom-left corner}).$$

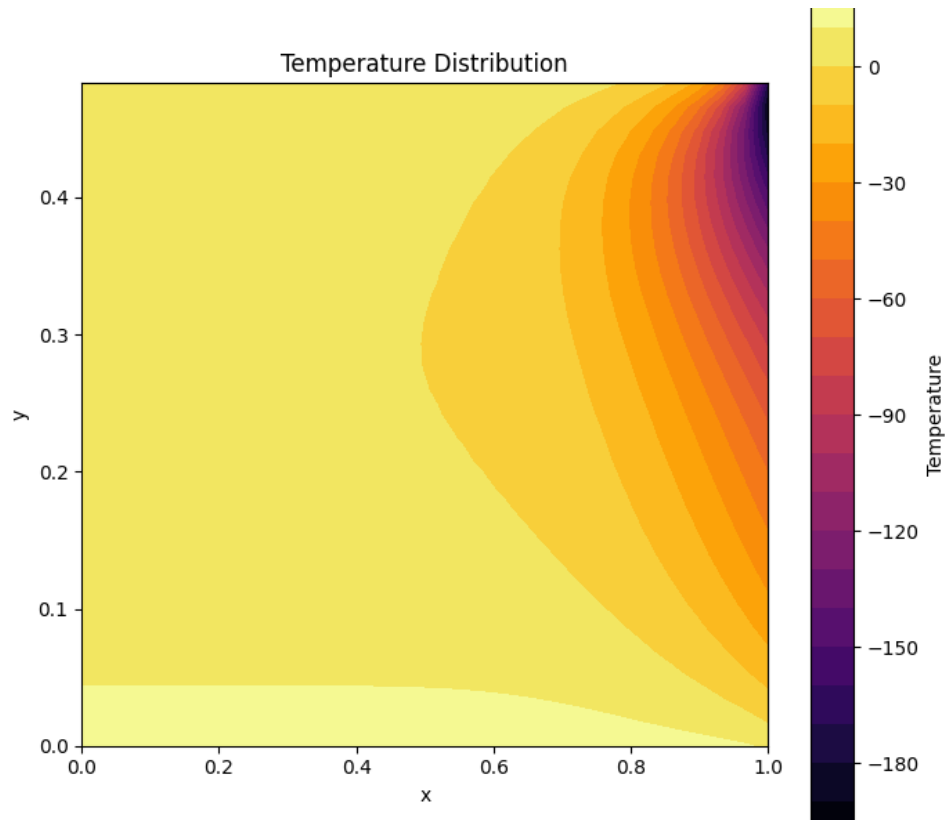
10x10 | $dx = 0.1$ | $dy = 0.05$



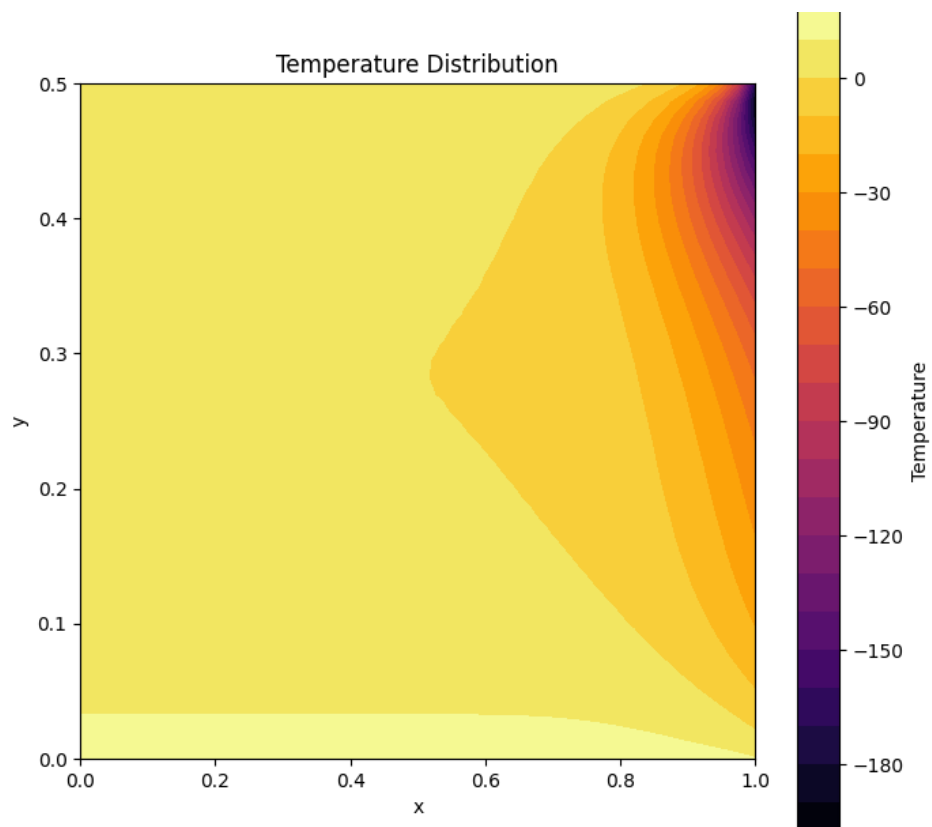
20x20 | $dx = 0.05$ | $dy = 0.025$

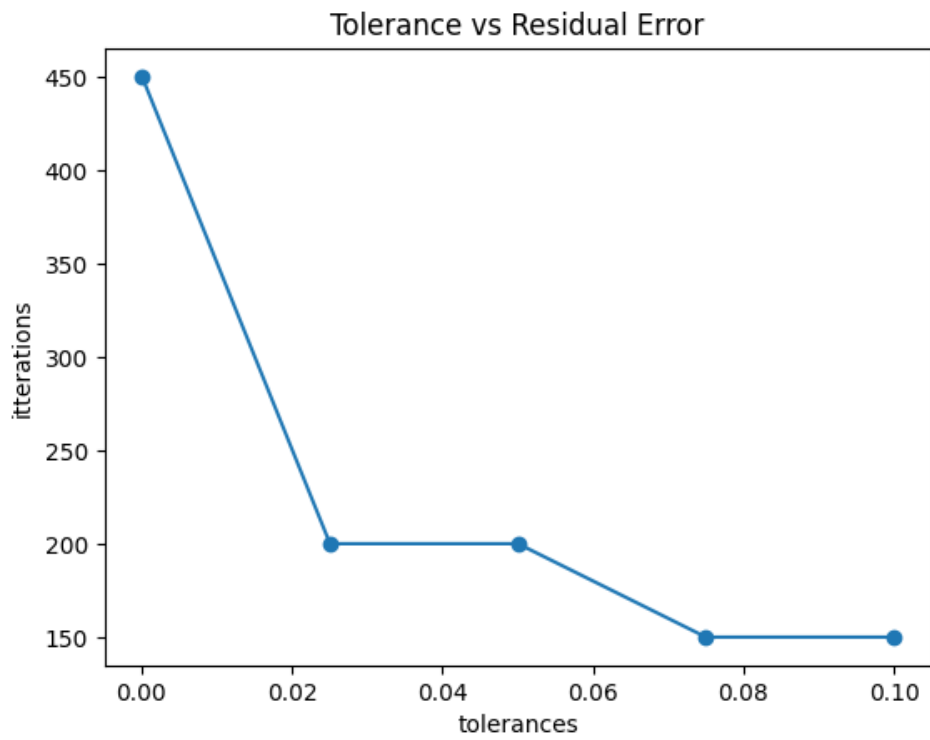


30x30 | $dx = 0.03333333333$ | $dy = 0.01666666667$

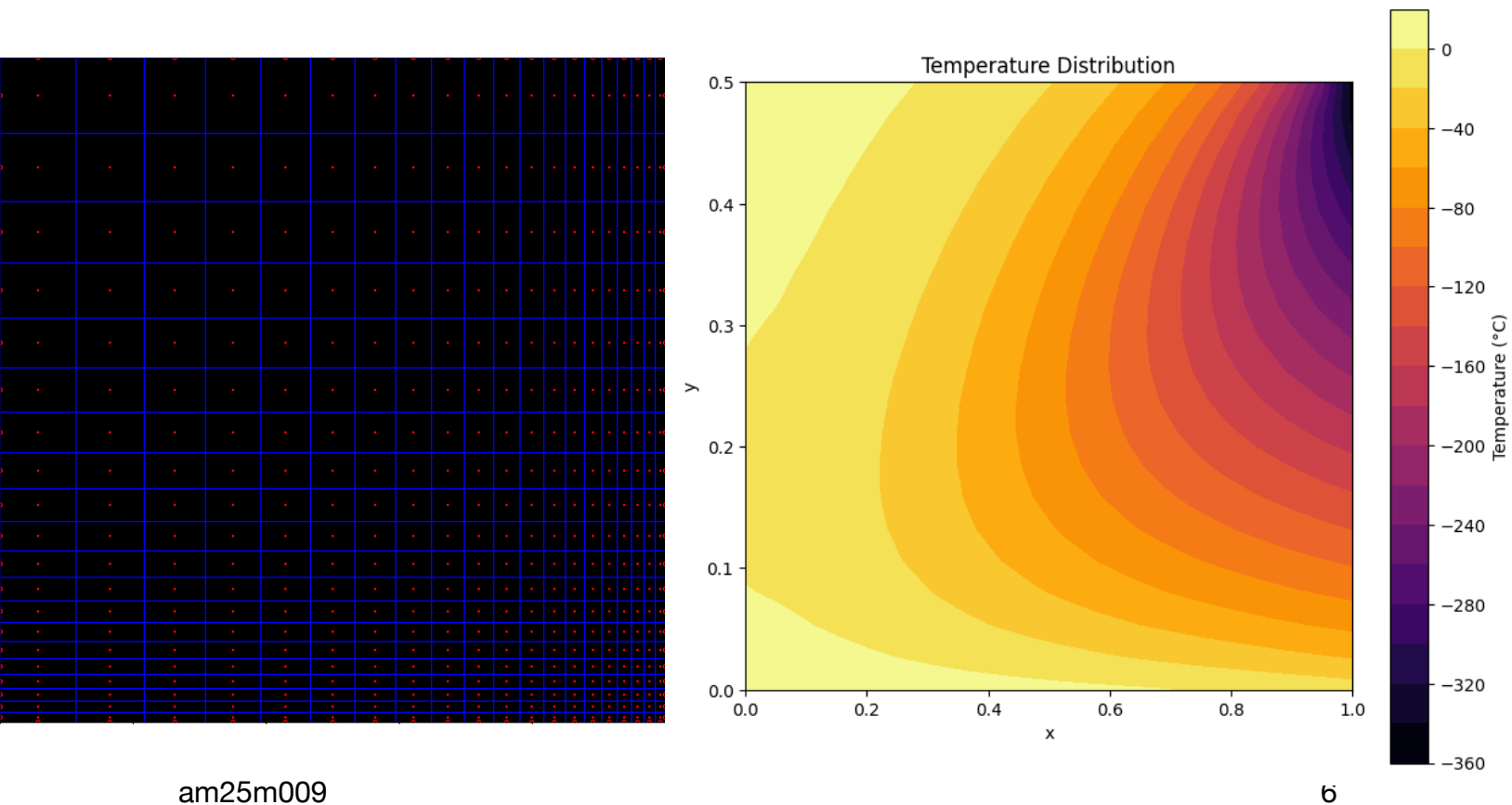


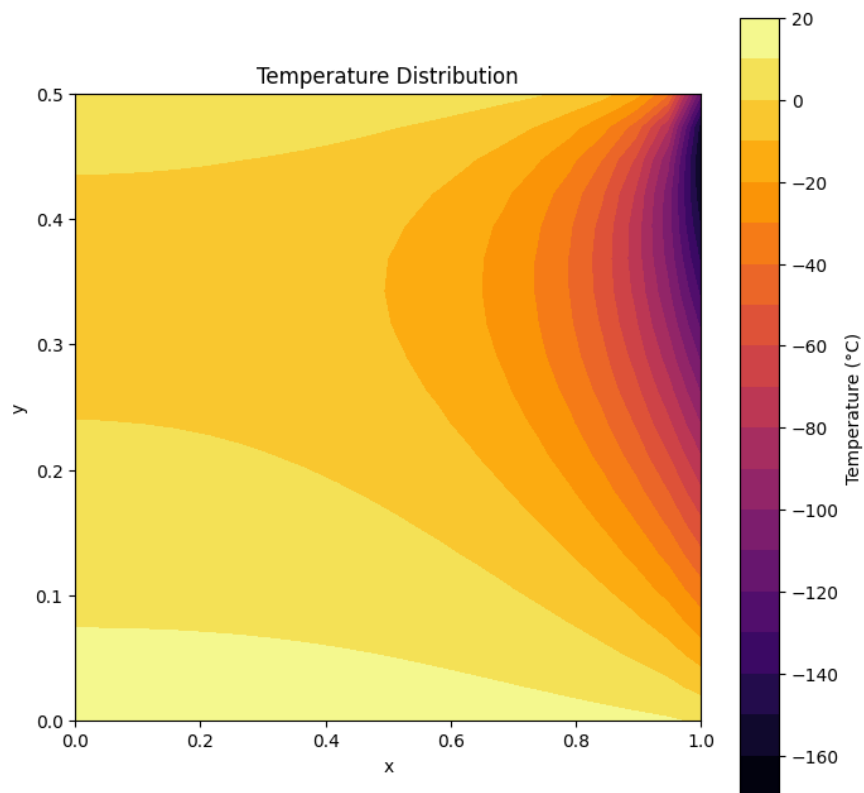
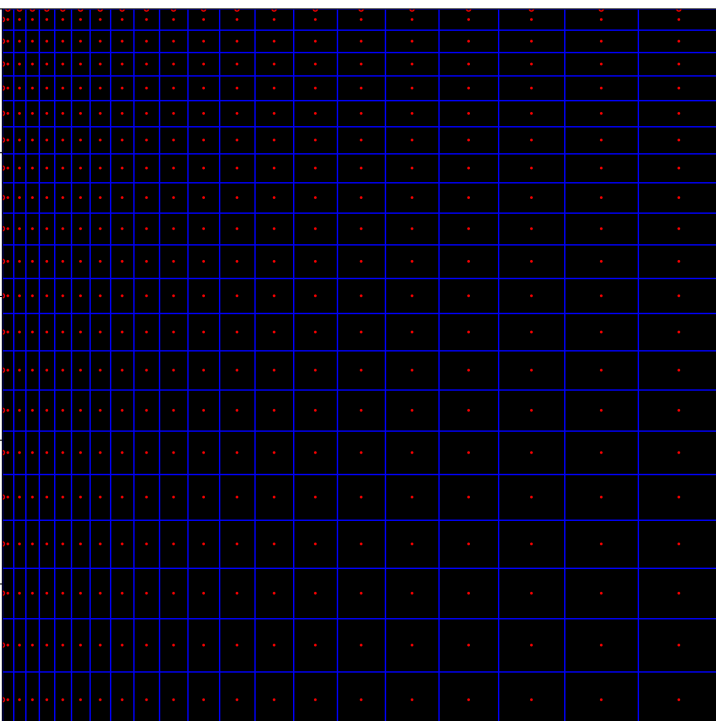
40x40 | $dx = 0.025$ | $dy = 0.0125$





BONUS: STRECH MESH





CODE:

<https://github.com/Mafaz03/Computational-Fluid-Dynamics/tree/main/2D%20Diffusion>

Run the: 2D_Diffusion.ipynb